MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2017/2018

ECE 3086 – MULTIMEDIA TECHNOLOGIES AND APPLICATIONS

(All sections / Groups)

16 OCTOBER 2017
9.00 A.M – 11.00 A.M
(2 Hours)

INSTRUCTION TO STUDENTS

1. This question paper consists of 7 pages (including cover page) with 5 questions.
2. Attempt all **FIVE** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the answer Booklet provided.

QUESTION 1

(a) Describe the four benefits of digital audio when compared to the analog version.

[4 Marks]

(b) The speech signal frequency is from 50 Hz to 10 kHz and for music signal, the maximum signal frequency can go up to 20 kHz.

i) Compute the bit rate obtained from encoding the speech signal using Pulse code modulation (PCM) if the minimum sampling rate is used to avoid aliasing. Calculate the bit rate from encoding **stereo** music with Nyquist sampling rate (minimum sampling rate). Assume 12 bits are used per sample for both speech and music.

[8 Marks]

ii) Discuss the impact of reducing the sampling rate by half and bits per sample by half on the quality of the reproduced audio signal.

[4 Marks]

(c) Video signal is commonly stored using YUV colour format rather than RGB format. Explain the benefit of such method in term of signal storage and transmission efficiency.

[4 Marks]

Continued ...

QUESTION 2

(a) A source with symbols {W, X , Y , Z} has the following probabilities: P(W)= 0.125, P(X)= 0.0625, P(Y)= 0.5, P(Z)= 0.3125.

i) With the use of Huffman coding method, design the optimal variable length code for the symbols. You will need to show the codeword for all the symbols.

[4 Marks]

ii) Show the Huffman code for the message "ZYYZ". Compute the compression ratio if the message use 8 bits fixed length code before compression.

[4 Marks]

(b) Describe how quantization can be used to compress a true colour RGB image that use 24 bits per pixel (8 bits for each colour component). Your proposed compression scheme should reduce the bit depth from 24 bits to 8 bits. Discuss briefly if quantization is a lossless or lossy process.

[6 Marks]

(c) An audio signal f is sampled and uniformly quantized. The signal value range from 0 to 10 V. Compute the quantized value $Q(f)$, equivalent binary code and quantization error for the values in Table 1. Assume 3 bits uniform quantization is used. Use Table 1 below as your reference.

Table 1: Quantization computation table

f	$Q_i(f)$ quantized index	$Q(f)$	Equivalent binary code	Quantization error e
5.00				
6.20				
6.25				

[6 Marks]

Continued ...

QUESTION 3

(a) Human eyes are more sensitive to distortion due to changes in luminance when compared to colour. Natural images are mostly dominated by low frequency signals. Based on these observation, propose how you would optimize the JPEG encoder in order to increase compression but still preserve the image perceptual quality. **Draw the complete JPEG encoder block diagram** to explain your proposal.

[8 Marks]

(b) Discuss one method to increase the compression ratio of the JPEG encoder. Explain the impact of this proposed method on the image quality.

[6 Marks]

(c) The pixel values of a 4x5 image is given in Figure 1 below. Use the Laplacian mask given in Figure 2 to find the new value for the target pixel at row three and column four after filtering. The target pixel has been highlighted in Figure 1 and has the value 90.

[6 Marks]

95	70	71	85	95
85	120	80	70	100
80	85	86	90	120
110	120	100	75	90

Figure 1

0	-1	0
-1	4	-1
0	-1	0

Figure 2: Laplacian Mask

Continued ...

QUESTION 4

(a) A digital video with resolution of 480x720, 30 frames/sec frame rate, 8 bits per pixel for each colour component value (Y, U and V) and a 4:2:0 chroma sub-subsampling scheme is used. The video uses progressive scan. Compute the bit rate for the raw video stream.

[6 Marks]

(b) What is the purpose of chroma subsampling in digital video? Why is it feasible to perform chroma subsampling in digital video?

[4 Marks]

(c) Figure 3 shows a generic video encoder block diagram. Explain briefly the processes in **block A and block B** and its role in video compression.

[10 Marks]

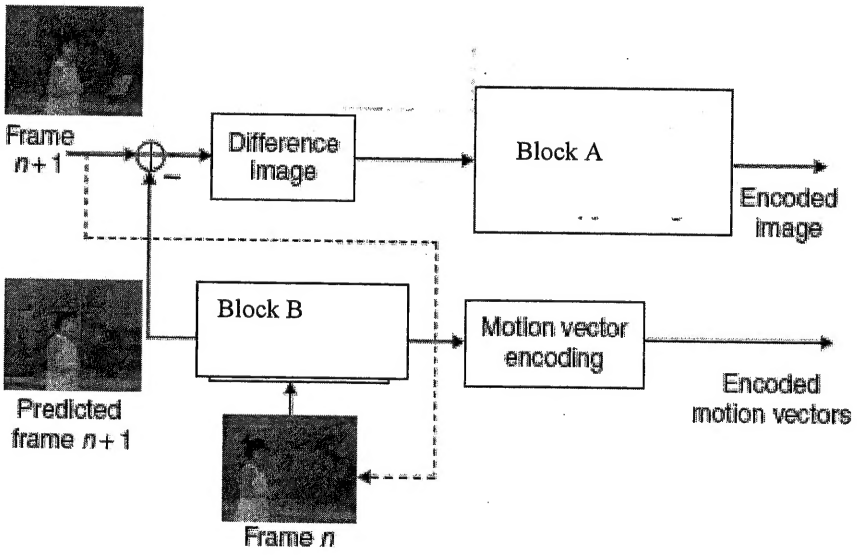

Figure 3

Continued ...

QUESTION 5

(a) The following block diagram in Figure 4 shows a simple content based image retrieval system based on query by example.

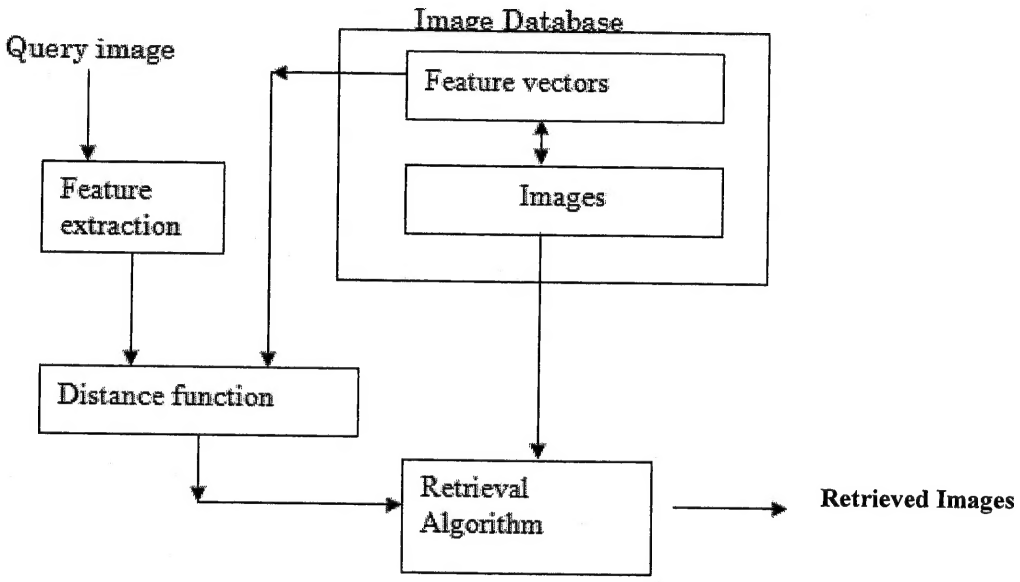

Figure 4

Explain briefly the term used in the block diagram.

(i) Feature extraction
(ii) Feature vector
(iii) Distance function
(iv) Retrieval algorithm

[12 Marks]

Continued ...

QUESTION 5

(b) Table 2 below defines some of the critical bands used in perceptual audio coding. The critical bands take into account the frequency masking effect. Use the information given in Table 2 to answer the following questions.

(i) A loud 560 Hz and 830 Hz tone is generated in the presence of a softer 900 Hz tone. Explain which of the tones can be heard.

[2 Marks]

(ii) Suppose a loud 150 Hz tone is generated together with the 200 Hz tone of equal loudness. Comment on the loudness of the combined tones. Give reason to support your answer.

[2 Marks]

(iii) Based on your earlier analysis, propose a coding or compression strategy to reduce the size of an audio data after compression. Explain by using the example in question 5 (b) i).

[4 Marks]

Table 2

Band #	Lower Bound (Hz)	Center (Hz)	Upper Bound (Hz)	Bandwidth (Hz)
1	-	50	100	-
2	100	150	200	100
3	200	250	300	100
4	300	350	400	100
5	400	450	510	110
6	510	570	630	120
7	630	700	770	140
8	770	840	920	150
9	920	1000	1080	160
10	1080	1170	1270	190
11	1270	1370	1480	210
12	1480	1600	1720	240

End of Paper